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TITLE: Transcoding using
block-based motion vectors

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PARENT-CASE:

   CROSS-REFERENCE TO RELATED APPLICATIONS

   This application is a divisional of U.S.
application Ser. No. 09/335,810,
filed on Jun. 18, 1999, abandoned, and claims the
benefit of the filing date
of U.S. provisional application No. 60/121,531,
filed on Feb. 25, 1999.

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Abstract Text - ABTX (1):
   An input encoded video bitstream conforming to a
first DCT-based image
compression standard (e.g., MJPEG or DV) is
converted into an output encoded

video bitstream conforming to a second DCT-based image compression standard
(e.g., MPEG) without having to fully decode the first bitstream according to
the first image compression standard and without having to fully encode
according to the second image compression standard in order to generate the
output bitstream. Rather, a **partial video decoder** of a transcoding system
applies steps of the first image compression standard to the input bitstream to
generate dequantized DCT coefficient data. A DCT data converter of the
transcoding system then processes the dequantized DCT coefficient data in the
DCT domain as necessary to enable a partial video encoder of the transcoding
system to apply steps of the second image compression standard to the converted
DCT coefficient data in order to generate the output bitstream. The processing
performed in the DCT domain by the partial video encoder includes motion
estimation at block boundaries.

Brief Summary Text - BSTX (14):
   The present invention is directed to techniques for transcoding input
encoded video bitstreams conforming to a first DCT-based image compression
standard (e.g., MJPEG or DV) into output encoded video bitstreams conforming to
a second DCT-based image compression standard (e.g., MPEG). As opposed to
brute-force transcoding techniques in which an input bitstream is fully decoded
and then fully re-encoded to generate an output bitstream, under the present

invention, the input bitstream is only **partially**
decoded according to the first
standard into the DCT domain (i.e., dequantized DCT
coefficients), and then the
re-encoding processing for the second standard
starts with those dequantized
DCT coefficients to generate the output bitstream.
Because transcoders of the
present invention only perform part of the full
decoding and encoding
processes, which do not include application of the
computationally expensive
inverse and forward DCT transforms, these
transcoders can be implemented using
PC-based software-only solutions and still meet the
throughput requirements of
many real-time applications. As such, the expense
of requiring full decoders
and encoders is avoided by the present invention.

Detailed Description Text - DETX (3):
    FIG. 1 shows a block diagram of a transcoding
system 100, according to one
embodiment of the present invention. Transcoding
system 100 converts an input
encoded video bitstream conforming to a first image
compression standard (e.g.,
MJPEG or DV) into an output encoded video bitstream
conforming to a second
image compression standard (e.g., MPEG).
Transcoding system 100 comprises a
partial video decoder 102, a DCT data converter
104, and a partial video
encoder 106. Depending on the particular
implementation, the various
components of transcoding system 100 can be
implemented in software, hardware,
or a combination of both.

Detailed Description Text - DETX (4):
    In particular, **partial video decoder** 102 applies
processing conforming to
the first image processing standard (e.g.,
variable-length decoding, run-length
decoding, and dequantization) to partially decode
the input encoded video
bitstream into dequantized DCT coefficient data.
DCT data converter 104
converts the dequantized DCT coefficient data
generated by **partial video**
decoder 102 into corresponding converted DCT
coefficient data for partial video
encoder 106, which applies processing conforming to
the second image
compression standard (e.g., quantization,
run-length encoding, and
variable-length encoding) to the converted DCT
coefficient data to generate the
output encoded video bitstream.

Detailed Description Text - DETX (5):
    The processing performed by **partial video**
decoder 102 may comprise any
suitable conventional processing techniques
conforming to the first image
processing standard in order to generate the
decoded DCT coefficient data from
the input encoded video bitstream. The processing
performed by DCT data
converter 104 in accordance with the present
invention will depend on the
particular video standards of the input and output
encoded video bitstreams.
Depending on the implementation, some or all of the
processing of DCT data
converter 104 may be optional. Depending on the
implementation, the processing

performed by partial video encoder 106 may comprise any suitable conventional
processing techniques conforming to the second image processing standard or it
may comprise special processing techniques in accordance with the present
invention. The processing of DCT data converter 104 and those portions of the
processing of partial video encoder 106 that are part of the present invention
are described in the following sections.

Detailed Description Text - DETX (9):
   where X is a 16.times.16 block of dequantized DCT coefficients formed by
concatenating a 2.times.2 region of four 8.times.8 blocks of dequantized DCT
coefficients generated by **partial video decoder** 102, T is an 8.times.16
transformation matrix, T.sup.t is the 16.times.8 transpose of T, and Y is the
resulting 8.times.8 block of converted DCT coefficients.

Detailed Description Text - DETX (23):
   FIGS. 2A-C and 3A-C show the relative sizes for corresponding regions of
pixel data for the YUV 4:1:1 and YUV 4:2:0 color formats. As shown in FIGS.
2A-C, for an H.times.W luma (Y) image, there are two H.times.W/4 chroma (U and
V) images. As shown in FIGS. 3A-C, for an H.times.W luma image, there are two
H/2.times.W/2 chroma images. In order for MPEG-compliant partial video encoder
106 of FIG. 1 to be able to generate an output bitstream conforming to the MPEG
standard (which does not support the 4:1:1 color

format), DCT data converter
104 is capable of converting dequantized DCT
coefficient data generated by
DV-compliant **partial video decoder** 102 from the YUV
4:1:1 color format into the
YUV 4:2:0 color format, which can be handled by
MPEG-compliant partial video
encoder 106.

Detailed Description Text - DETX (25):
   where X is a 16.times.8 block of chroma (U or V)
DCT coefficient data formed
by vertically concatenating two 8.times.8 blocks of
chroma DCT coefficient data
generated by **partial video decoder** 102 of FIG. 1,
T.sub.c is a 8.times.16
column-wise transformation matrix, T.sub.r is an
8.times.16 row-wise
transformation matrix, and Y is the resulting
8.times.16 block of transformed
chroma DCT coefficient data.

Detailed Description Text - DETX (32):
   Another major difference between DV bitstreams
and MPEG bitstreams is the
possible existence of encoded video data in a DV
bitstream that was encoded
based on the DV 2-4.times.8 mode. In order for
MPEG-compliant partial video
encoder 106 of FIG. 1 to be able to generate an
output bitstream conforming to
the MPEG standard (which does not support the
2-4.times.8 mode), DCT data
converter 104 is capable of converting dequantized
DCT coefficient data
generated by DV-compliant **partial video decoder** 102
from 2-4.times.8 mode to
8.times.8 mode, which can be handled by

MPEG-compliant partial video encoder
106.

Detailed Description Text - DETX (34):
    where X.sub.e and X.sub.o are corresponding
4.times.8 blocks of even and odd
DCT coefficients as defined by Equations (1) and
(2), respectively, and
generated by **partial video decoder** 102 of FIG. 1.
The 8.times.4 transformation
matrices T.sub.1 and T.sub.2 can be represented by
Equations (19) and (20) as
follows:

Detailed Description Text - DETX (38):
    When implementing the matrix multiplication
transformation of Equation (18),
DCT data converter 104 of FIG. 1 converts each
corresponding pair of even and
odd 4.times.8 DCT blocks (i.e., X.sub.e and
X.sub.o) generated by **partial video
decoder** 102 into a single 8.times.8 block of DCT
coefficients (Y) for
processing by partial video encoder 106.

Detailed Description Text - DETX (41):
    The following sections describe some of
processing techniques performed by
partial video encoder 106 of transcoder 100 of FIG.
1, when the input encoded
video bitstream is either an MJPEG or DV bitstream
and the output encoded video
bitstream is an MPEG bitstream, according to one
embodiment of the present
invention. These processing techniques relate to
requantization for
rate-control, inter-frame encoding in the DCT

domain, motion compensation in
the DCT domain, inter/intra mode decision in the
DCT domain, and field/frame
mode decision in the DCT domain. As described
below, all of these techniques
involve manipulating the DCT coefficient data
generated by **partial video**
decoder 102 and/or DCT data converter 104 of FIG.
1.

Detailed Description Text - DETX (43):
   Depending on the particular application, there
may be a need to reduce the
number of bits used to represent the video content
in the output encoded video
bitstream, even after the resizing operations of
DCT data converter 104 are
implemented. One way to control the bit rate of
the output bitstream is to
adjust the quantization levels used during the
requantization processing
performed by partial video encoder 106. According
to the MJPEG and DV
standards, every block (or macroblock) in an MJPEG
or DV file is encoded using
the same quantization level. On the other hand,
the MPEG standards allow the
quantization level to vary from frame to frame and
even from macroblock to
macroblock within a frame. Thus, during
MJPEG-to-MPEG transcoding, the
possibility exists for partial video encoder 106 to
vary quantization level on
a macroblock basis from the MJPEG quantization
level used by **partial video**
decoder 102 in generating the dequantized DCT
coefficients.

Detailed Description Text - DETX (45):
    where y is the corresponding dequantized DCT
coefficient generated by
partial video decoder 102 and optionally converted
by DCT data converter 104,
Qjpeg is the quantization level at which the
original MJPEG DCT coefficient
data was quantized, and Qmpeg is the selected MPEG
quantization level for the
current macroblock, where Qmpeg may be represented
by Equation (24) as follows:

Detailed Description Text - DETX (59):
    Another mode decision supported by the MPEG
standard is the field/frame mode
decision in which it is determined whether to
encode an image as a single frame
or separated into the upper and lower fields of a
single interleaved image. In
conventional MPEG algorithms, the field/frame mode
decision is made in the
pixel domain. According to embodiments of the
present invention, the
field/frame mode decision is made in the DCT domain
by comparing the variance
for the frame DCT mode to the variance for the
field DCT mode and selecting the
mode having the smaller variance. For DV and MJPEG
input bitstreams, the
dequantized DCT coefficient data generated by
partial video decoder 102 will
already be structured in frame format. As such,
the variance Vframe for the
frame DCT mode can be computed directly from that
dequantized DCT coefficient
data using Equations (26) and (27).

Detailed Description Text - DETX (64):

FIG. 4 shows a flow diagram of the DV-to-MPEG
transcoding processing
performed by transcoding system 100 of FIG. 1,
according to one embodiment of
the present invention. Transcoding processing
begins with **partial video**
decoder 102 of FIG. 1 partially decoding an input
encoded video bitstream
conforming to the DV standard to generate a set of
dequantized DCT coefficients
for each frame of DV-encoded data (step 402).

Claims Text - CLTX (13):
    13. A transcoding system for converting an
input encoded video bitstream
conforming to a first DCT-based compression
algorithm into an output encoded
video bitstream conforming to a second DCT-based
compression algorithm
different from the first compression algorithm,
comprising: (a) a **partial video**
decoder configured to apply decoding steps
conforming to the first compression
algorithm to the input bitstream to generate
dequantized DCT coefficient data
in a DCT domain; and (b) a partial video encoder
configured to: (1) perform
motion-compensated inter-frame differencing on the
dequantized DCT coefficient
data in the DGT domain based on motion vectors ,
corresponding to block
boundaries without performing an inverse transform;
 and (2) apply encoding
steps conforming to the second compression
algorithm to the motion-compensated
inter-frame DCT coefficient difference data to
generate the output bitstream.

Current US Cross Reference Classification - CCXR
(2):
   382/233